ORIGINAL

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

In the Matter of	
Revision of the Commission's Rules To Ensure Compatibility with Enhanced 911 Emergency Calling Systems	CC Docket No. 94-102 RM-8143

ALLTEL PETITION FOR WAIVER OF SECTION 20.18(c)

Pursuant to Section 1.3 of the Federal Communications Commission's ("FCC" or "Commission") Rules[1] and the Commission's Order released November 13, 1998,[2] ALLTEL Corporation ("ALLTEL")[3] requests that the Commission waive Section 20.18(c) of the Commission's Rules, to the extent that the rule requires digital wireless systems to

[1] 47 C.F.R. § 1.3.

[2] *Revision of the Commission's Rules To Ensure Compatibility with Enhanced 911 Emergency Calling Systems*, CC Docket No. 94-102, RM-8143, Order, (Nov. 13, 1998) ("November 13 Order").

[3] ALLTEL is a diversified telecommunications and information services holding company, whose subsidiaries and affiliates offer a full array of communications services. ALLTEL's subsidiaries and affiliates (as a matter of record with the Commission) hold various PCS licenses and numerous cellular licenses for markets across the United States. ALLTEL's subsidiaries and affiliates also provide paging, local wireline services (including competitive local exchange services), long distance resale services, data services, Internet access services, and cable television services. ALLTEL is filing the instant waiver request on behalf of each of its various subsidiaries and affiliates providing either PCS and/or cellular service, and therefore, subject to Section 20.18(c). ALLTEL will provide a complete list of these licensees should the Commission so request.

transmit 911 calls from text telephone ("TTY") devices by December 31, 1998. Recognizing that digital wireless systems will not be technically able to transmit 911 calls by January 1, 1999, the FCC in its November 13 Order established a mechanism to allow such wireless carriers to petition the Commission for a waiver of Section 20.18(c).[4]

As ALLTEL demonstrates below, it has participated actively in industry and consumer groups, working together to develop interim and long-term solutions as well as timetables and testing standards for the implementation of digital 911/TTY solutions and has consequently satisfied all requirements for grant of a waiver of Section 20.18(c).

I. BACKGROUND

In its initial order adopting Section 20.18(c), the Commission recognized that certain technological barriers could prevent digital carriers from complying with the rule.[5] In the order, the Commission required that, as of October 1, 1997, all covered carriers must be capable of transmitting 911 calls from individuals with speech or hearing disabilities through means other than mobile radio handsets, *e.g.*, through the use of text telephone (TTY) devices. However, the Commission suspended enforcement of this requirement until October 1, 1998, for all TTY/911 calls transmitted on digital systems.[6]

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[4] To maintain the waiver, the Wireless Telecommunications Bureau ("Bureau") requires carriers to file submissions every three months indicating the progress they are making toward implementation of TTY/digital capability.

[5] *Revision of the Commission's Rules To Ensure Compatibility with Enhanced 911 Emergency Calling Systems,* 11 FCC Rcd 18676 (1996), Report and Order and Further Notice of Proposed Rulemaking, ("E911 First Report and Order"), *recon.*, 12 FCC Rcd 22665 (1997) ("E911 Reconsideration Order").

[6] E911 Reconsideration Order at 22694-95.

The Commission concluded that the additional time would "allow the wireless industry, working with organizations representing individuals with hearing and speech disabilities, to overcome technical barriers and compatibility problems involved in implementing solutions for TTY users on digital wireless systems."[7] The Commission also delegated to the Bureau the authority to grant up to a three-month extension of the October 1, 1998, deadline (*i.e.*, to January 1, 1999).[8]

ALLTEL is a member of the Wireless TTY Forum ("Forum"), an organization of wireless carriers, equipment manufacturers, manufacturers of TTY equipment, emergency and relay service providers, and consumer organizations representing speech or hearing impaired individuals. Since September 1997, the Forum has undertaken intensive collaborative efforts to develop technically feasible solutions for TTY users to access 911 over digital wireless systems. Nonetheless, the Forum has been unable to resolve all the difficult technical issues presented by TTY use over digital wireless systems and no digital technology has been determined to be capable of reliably transmitting TTY communications. Consequently, the Cellular Telecommunications Industry Association ("CTIA") and the Personal Communications Industry Association ("PCIA"), in a letter dated September 11, 1998,[9] requested that the Bureau grant a three-month extension of the October 1, 1998 deadline.

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[7] *Id.* at 22695.

[8] *Id.*

[9] Letter from A. Williams, Assistant General Counsel, CTIA, and M. Jones, Vice President of External Affairs, PCIA, to D. Phythyon, Chief, Wireless Telecommunications Bureau.

In support of their request, CTIA and PCIA provided a draft workplan for the Forum's future activities, which identified specific actions that will help develop "short-term" and "long-term" solutions for TTY access over digital wireless systems.[10] The complexity of the issues involved prevented the Forum from providing a specific implementation schedule in the draft workplan. In response, the Bureau requested additional information to be submitted by October 30, 1998 and granted a limited extension of the deadline until November 15, 1998.[11]

On October 30, 1998, CTIA submitted the Workplan of the Wireless TTY Forum[12] identifying possible solutions for TTY access over digital wireless systems.[13] Although the Bureau recognized that the Workplan estimated the time for implementation of a data-based solution to be between 12 to 18 months,[14] the Bureau extended the suspension of enforcement of Section 20.18(c) only through December 31, 1998. The Bureau also established procedures under which wireless carriers subject to the requirements of Section

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[10] Short-term solutions would achieve "backward" compatibility with existing TTY devices (which transmit information using Baudot-coded audio tones). Long-term solutions would send 911 calls over digital wireless networks in the form of data transmissions.

[11] *Revision of the Commission's Rules To Ensure Compatibility with Enhanced 911 Emergency Calling Systems*, CC Docket No. 94-102, Order at ¶ 8 (Sept. 30, 1998) ("September 30 Order").

[12] Wireless TTY Forum Workplan: TTY Access Over Digital Wireless Systems; attached to CTIA and PCIA Joint Comments filed Oct. 30, 1998 ("Workplan").

[13] ALLTEL incorporates the Workplan and timetable herein by reference, as well as the Wireless TTY Forum Quarterly Status Reports and Reports submitted to the Commission by the CDG.

[14] November 13 Order at ¶ 5 n. 4 (citing the Workplan at Appendix C).

20.18(c) may petition the Commission, not later than December 4, 1998, for waivers of such requirements, which, if granted, will take effect on January 1, 1999.

II. ARGUMENT

A. ALLTEL Satisfies The Commission's Requirements For Grant Of A Waiver Of Section 20.18(c)

The November 13 Order requires petitions for waiver to address the following:

(1) What steps the carrier is taking or intends to take to provide users of TTY devices with the capability to operate such devices in conjunction with digital wireless phones.
(2) When the carrier intends to make this capability available to TTY users. This information should include well-documented timetables and milestones from the carrier regarding the implementation of this capability.
(3) What reasonable steps the carrier will take to address the consumer concerns referenced in the September 30 Order.[15]

ALLTEL has worked actively with the Forum from its inception to construct a Workplan that will allow carriers and equipment manufacturers to develop, in conjunction with consumer groups representing speech or hearing impaired persons, a standard for digital 911 services. As part of the TTY Forum's efforts, digital wireless phone manufacturers have done extensive testing of digital air interfaces coupled with existing TTY devices. The results show that CDMA, TDMA, iDEN and GSM wireless phones have inherent problems in correctly transmitting the audible Baudot[16] tones from a TTY terminal

[15] November 13 Order at ¶11(citing September 30 Order).

[16] The Baudot code as implemented in TTY devices consists of audible tones that represent characters being typed on the TTY keyboard.

when it is coupled through the phone's vocoder.[17] Initial tests exhibited character error rates well in excess of the one percent achieved through analog transmissions and demanded by consumer groups.[18]

Forum members will continue to work diligently together to develop a standard which meets the one percent character error rate specified as acceptable by consumer groups representing speech or hearing impaired persons. To that end, the Forum has developed a Standards Requirement Document that defines a switched circuit data approach for providing TTY communications over all types of digital networks (*i.e.*, CDMA, TDMA, iDEN, and GSM networks). Although the unpredictability of test results makes specific implementation timetables difficult to estimate accurately, the Forum expects that 12 to 36 months will be required to properly implement the new standard.

As a carrier using the CDMA protocol, ALLTEL has also been an active leader in the CDMA Development Group TTY/TTD Team ("CDG"). The CDG has formulated a laboratory and field test procedure to establish an objective test for measuring the performance of TTYs over CDMA networks.[19] CDG also is developing testing procedures for the data services approach proposed by the Forum. ALLTEL also regularly

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[17] A vocoder is an electronic mechanism that reduces speech signals to slowly varying signals which can be transmitted over communications systems of limited frequency bandwidth.

[18] Workplan at 2 n. 1.

[19] A summary of the CDG's activities and test procedure plan is attached hereto as Exhibit A.

communicates with its switch and customer equipment vendors regarding the vendors' plans and timetables for developing CDMA/TTY compatible equipment.[20]

Both groups, the Forum and the CDG, devised their plans to address and accommodate, where technically feasible, the concerns of the consumer representatives as specified in the appendix to the September 30 Order. The appendix contains a set of criteria that the consumer representatives devised to address the functional characteristics of possible solutions. ALLTEL is pooling its resources, including the dedication of personnel, with the other members of the CDG to test equipment to determine whether the equipment meets the Customer Representatives' criteria. The CDG provided its CDMA TTY/TTD Test Procedure report to the FCC on November 13, 1998. The Test Procedure reports the results of previous equipment testing, provides schedules for further equipment testing and discusses CDG's plans for developing data services option test procedures and evaluating current voice and data proposals.

In the interim, ALLTEL commits to maintaining its analog wireless network until its digital network can comply with Section 20.18(c). ALLTEL also is continuing to take measures to notify its current and new customers that TTY calls to 911 may not be available over its digital networks. For example, during the month of December, ALLTEL will specify in its customer bills that 911 access over TTY is not currently accessible through its digital handsets.[21] Furthermore, by no later than January 1, 1999, the packaging containing

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[20] An example of correspondence between ALLTEL and one of its vendors is attached hereto as Exhibit B. Discussions with other vendors has regularly taken place on an oral basis.

[21] The text of the notices used by ALLTEL is largely based on text recommended by CTIA.

new digital handsets will be labeled as "not TTY compatible." ALLTEL also will include a description of the TTY/911 issues in the customer information packets which it provides to all of its new customers.

ALLTEL's ability to provide detailed solutions with specific timetables is hampered by the fact that equipment test results are unpredictable. Should the Bureau deny the instant waiver request, its decision would be tantamount to requiring ALLTEL to provide service when such service is technologically impossible. ALLTEL notes that Section 255 of the Communications Act, the congressional authority for Section 20.18(c), states that a "provider of telecommunications service shall ensure that the service is accessible to and useable by individuals with disabilities, *if readily achievable*."[22] "Readily achievable" is defined by the American with Disabilities Act as "easily accomplishable and able to be carried out without much difficulty or expense."[23] Providing a service that is not technologically possible would not appear to be "readily achievable."

ALLTEL will continue to work diligently with the Forum and CDG and, where feasible, will implement any solutions provided by the groups that will allow ALLTEL to comply with Section 20.18(c). ALLTEL also expects to adhere to the timetable provided by the Forum in its Workplan. ALLTEL has demonstrated that it meets all the requirements

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[22] 47 U.S.C. § 255(c) (emphasis added).

[23] 42 U.S.C. § 12181(9).

for waiver of Section 20.18(c) outlined in the November 13 Order and its waiver request should be granted.[24]

III. CONCLUSION

ALLTEL respectfully requests that the Commission grant its request for waiver of the requirements of Section 20.18(d).

Respectfully submitted,

By: _____

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Counsel for ALLTEL Corporation

December 4, 1998

[24] ALLTEL will supplement the information herein with any additional information the FCC deems necessary to grant the waiver request.

Certificate of Service

I, Kimberly E. Thomas, do hereby certify that the foregoing **PETITION FOR WAIVER OF SECTION 20.18(c) by ALLTEL** were delivered, via hand delivery, on this 4th day of December, 1998, to the following:

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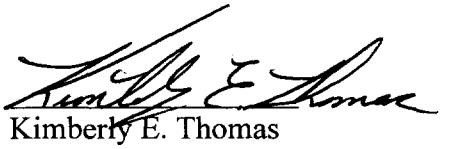


Kimberly E. Thomas

dc-139838

EXHIBIT A

cdmaOne™

CDMA Development Group

Steering Committee

TTY/TDD Team

November 17, 1998
Los Angeles, CA

Overview

Background

Update

Next Steps

Background

Separated from Location Technology team in 1997

Addressing FCC requirement to provide TDD/TTY capability for supporting E911 calls

- FCC extended October 1, 1998 deadline
  - Requiring participation in industry-wide work plan to achieve capability as soon as possible
- Industry required to provide regular progress reports
  - CDG providing input directly to FCC and through CTIA forum

Update

Member companies previously completed initial tests to identify ability to meet requirements

- Primary challenge is result of cdmaOne power control algorithm

As part of granting an extension to the Oct 1st deadline, FCC is requiring further testing to ensure consistent test results

- Each industry group required to develop test procedure
- Each industry group required to provide test dates

CDG has provided this input

- Test procedure (appendix) submitted to FCC on Nov 3
- Schedule of tests
  - BAM to complete tests by end of December; manufacturers include:
    - Audiovox, LGIC, Motorola, Nokia, QUALCOMM, Sony
  - Sprint PCS has completed tests of Samsung

Developing test procedure for Data Service Option approach

Reviewing proposals for solutions

Next Steps

Conduct TTY/TDD tests and submit results to FCC

Develop Data Service option test procedures

Evaluate current proposals

- Voice
- Data

CDMA TTY/TDD
Test Procedure

[attachments]

[CTIA plan]

[CDG plan]

TTY Over CDMA
Laboratory and Field Test Procedure

Version:	0.3
Last Revision Date:	November 3, 1998
Filename:	TESTPROC.DOC
Abstract:	The purpose of this document is to establish an objective test for measuring the performance of TTYs over CDMA Networks.

DOCUMENT REVISION HISTORY

VERSION	DESCRIPTION	DATE	CREATED/UPDATED BY
0.3	Updated by the CDG TTY Team for CDMA testing	11/03/98	Nikolai Leung

TABLE OF CONTENTS

TTY OVER CDMA TEST PROCEDURE

1. OVERVIEW

1.1 INTRODUCTION

This procedure defines a configuration in which a TTY device can be objectively tested over any CDMA network.

In a field test, there are uncontrolled elements which cause a greater variation in test results. The tests in this procedure will first be executed in a laboratory, so that all test conditions will be repeatable over multiple tests. After results have been achieved through documented laboratory configurations that are equal to or better than analog (with the already agreed upon one phone one technology approach), the test will be repeated in a real world environment. The lab test should be the identification stage of configurations to be submitted for the one phone one technology agreement. During this stage, it is very important that all manufactures of CDMA handsets and TTY manufactures participate, as results of this laboratory test stage will be used in the field test stage. The field test shall be used as verification of the laboratory tests. Once results are reached that are equal to or better than analog, the second stage of laboratory testing can begin. The second stage (not specified in this document) shall include the wire-line 9-1-1 network with the calls going to a Public Safety Access Point (PSAP) with the existing TTY equipment in use today. The test scripts used in the second stage of testing shall be designed for real life applications, determining that configurations submitted actually do perform equal to or better than analog. These test scripts shall be designed by subject matter experts (SMEs) in TTY call processing to 9-1-1 PSAPs. These test scripts shall first be executed over an analog wireless network, and then with a CDMA network to compare the final results in determination of equality. These test scripts should consider use of VCO/HCO.

1.2 SCOPE

It is not the intention of this document to define acceptance criteria, but rather provide an even playing field where all devices and cellular formats can be evaluated. The evaluation and interpretation of the data are not addressed. Test

results shall be recorded in terms of Printed Character Error Rates (PCER), and Total Character Rates (TCER). In order to re-run portions of this test, wherever possible TTY audio shall be recorded.

1.3 DESCRIPTION OF TEST STRATEGY

1.3.1 Baseline Measurements for CDMA

Due to the difficulty in determining acceptable performance criteria of script transmission over a CDMA network, it is it is required that a baseline first be determined. Currently, Analog cellular has been accepted by the general public for TTY communication, and should therefore be used as a baseline for CDMA testing. Each test called out in this procedure shall first be base-lined with an analog test, the results to be compared to the CDMA tests. Therefore, if a car driving 65MPH is not capable of scoring a low Character Error Rate using analog technology, it is not reasonable to expect better low Character Error Rates from a CDMA technology.

All tests shall be run using the CDMA 13k (IS-733) vocoder[1]. Tests shall be run on either 800MHz or 1900MHz systems depending on what service is available at the test site (the use of cellular or PCS band classes should not influence the test results, the vocoders operate identically in both band classes). For record keeping, the frequency band used shall be noted.

1.3.2 Stage 1 Test Script

Much attention has been placed on the test script and it's evaluation method. A script of randomly generated characters alternating between letters and figures has been generated. The code used to generate the test script is located in Appendix A, and the script itself in located in Appendix B. The test script contains 4216 characters, and the number of shift characters generated by the TTY will be 2012. There is a maximum of eight consecutive letters or figures, and a maximum total of 6228 characters will be scored. The scoring guidelines have been modified as they apply to shift errors, please see section 0 for details. Note: If the TTY does not have an external input capability via the serial or parallel port, then the TTY's internal character generator may be used to generate the characters.

[1] For consistency, the 8k (IS-96) vocoder shall not be used for testing. This lower-rate vocoder provides lower speech quality than the 13k vocoder and is not as widely deployed in CDMA networks.

1.3.3 Additional Stop BITS (optional)

In TTY devices, there is no formal specification for the quantity of stop bits, only a recommended minimum of 1.5. Therefore, each TTY manufacturer may vary the quantity of stop bits as they see fit. If additional stop BITS are to be used during these tests, they may only be used in the direction from the MS TTY to land TTY. In addition, a maximum of three additional stop bits (five stop BITS total) may used for each character. This delay will reduce the Word per Minute (WPM) rate from 68.18 WPM to 49.58 WPM (based on five character words and two stop bits).

Additional Stop BITS	Bit Rate	Add'l Stop BIT Time	Word Rate	WPM
0	2.20E-02	0.00E-00	8.80E-01	68.18
1	2.20E-02	2.20E-02	9.90E-01	60.60
2	2.20E-02	4.40E-02	1.10E+00	54.54
3	2.20E-02	6.60E-02	1.21E+00	49.58

1.3.4 Signal Strengths

For these tests, three coverage conditions have been selected. These conditons are based on averaged Forward link frame error rate (FER) metrics measured at the mobile station.

1.3.4.1 Strong Coverage

The strong signal test is representative of communication within close proximity to a base station. A Forward Link FER of 1% (averaged over a sliding 5 second window) is selected.

Forward link: generally achieved if the mobile station received Pilot Ec/Io is greater than -10 dB.

Reverse Link: implies mobile station transmit power is sufficient to close the reverse link in a manner that the reverse link FER targets can be met (with the reverse Eb/No setpoint near its lower limit).

1.3.4.2 Moderate Coverage

Forward link: generally achieved if the mobile station received Pilot Ec/Io is between the range of -10 to -14 dB.

Reverse Link: implies mobile station maximum transmit power is sufficient to close the reverse link in a manner that the reverse link FER targets can be met.

1.3.4.3 Weak Coverage

Forward link: the mobile station received Pilot Ec/Io is less than -14 dB.
Reverse Link: implies mobile station maximum transmit power (which is between 23 to 30 dBm, the min/max bounds on max Tx power, respectively) is insufficient to close the reverse link in a manner that the reverse link FER targets can be met (with the reverse Eb/No setpoint near its upper limit).

1.3.5 Test Equipment Configuration

At this time there is no standardized interface between TTY devices and CDMA Phones. There are variations in interface connectors and voltages. It is required that the MS and TTY be "matched" before reliable testing can proceed (see section 3.1).

2. TEST ENVIRONMENT

2.1 HARDWARE REQUIREMENTS

Hardware required for this test include:

- TTY device to be tested over CDMA Network.
- CDMA Phone (MS).
- Ultratec InteleModem
- One Soundblaster Sound Card (or equivalent)
- Two Personal Computers (i386 or better) with:
  4 MB of RAM (minimum)
  3.5 MB (minimum) of hard disk space for the NexTalk program,
  Microsoft Windows 3.1, Windows 95 or Windows NT,
  One unused ISA bus slot for internal sound card.
- Laptop Computer (i386 or better) with:
  One RS-232 port available
  4 MB of RAM (minimum)
  3.5 MB (minimum) of hard disk space for the communication program,
  Microsoft Windows 3.1, Windows 95 or Windows NT,

2.2 TOOL REQUIREMENTS

Tools required for this test include:

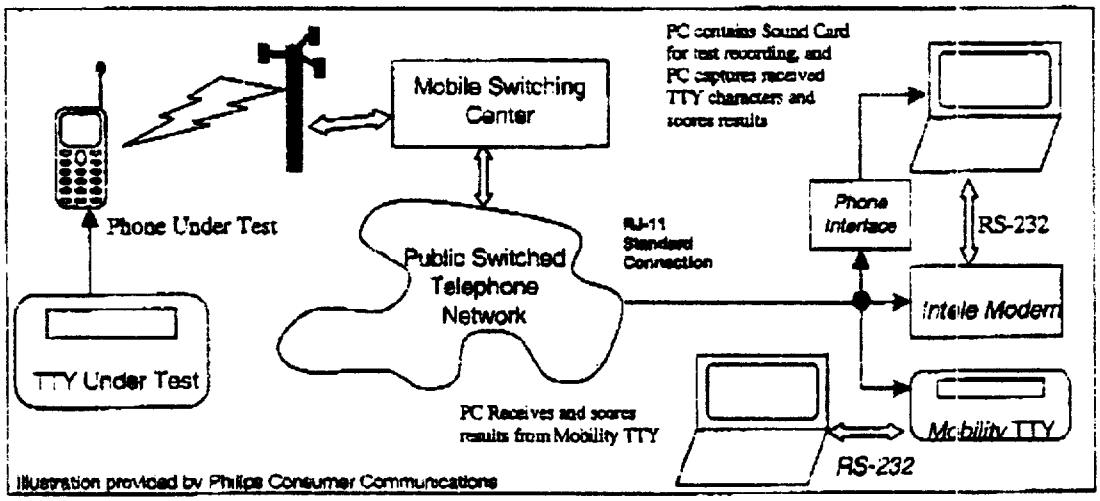
- Diagnostic Monitor or other device capable of measuring the full-rate frame error rate (FER) measurements for the Forward and Reverse traffic Channels.
- Software utility to objectively score test results (i.e. Score application from Lober & Walsh Engineering, Inc.).

- Hyperterm or other communication software package.
- Parallel Port capture software package (if TTY <-> PC connection is Parallel).
- RS-232 cable and adapters.
- Parallel cable , depending on the TTY <-> PC connection.
- TTY to Cellular Phone interface cable.

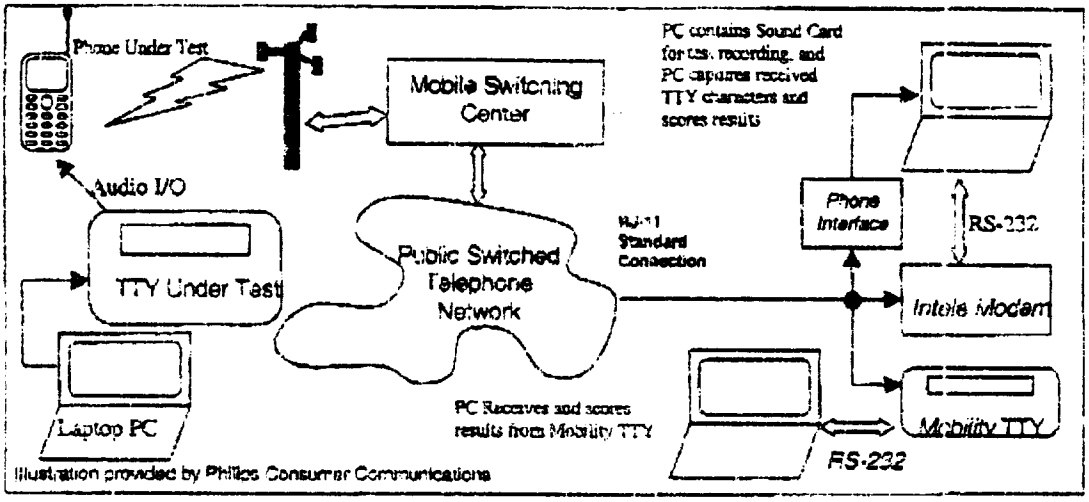
2.3 PHYSICAL CONFIGURATIONS

- Static Mobile Originated (Mobile to Land, fixed location)
- Static Mobile Terminated (Land to Mobile, fixed location)
- Dynamic Mobile Originated (Mobile to Land, moving mobile)
- Dynamic Mobile Terminated (Land to Mobile, moving mobile)

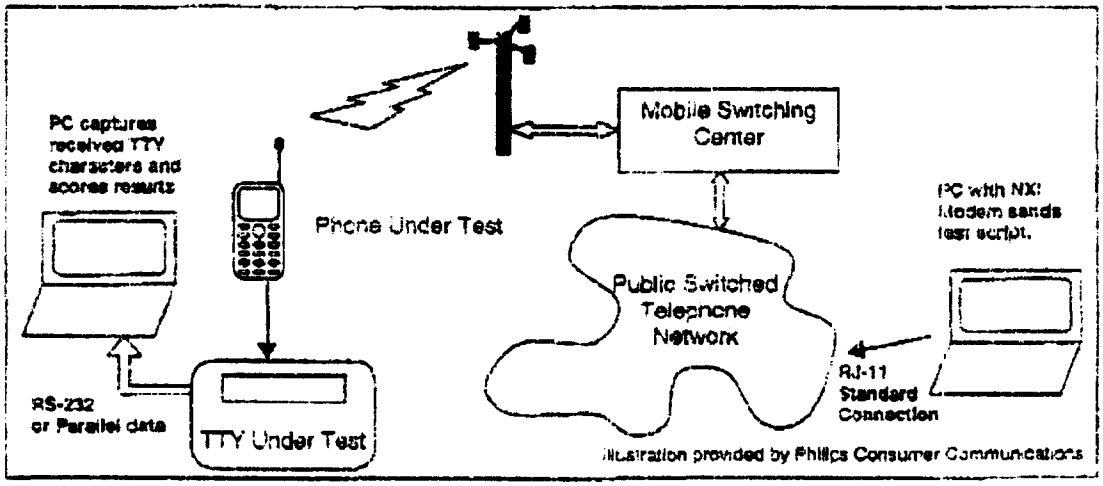
Mobile Origination Configuration #1

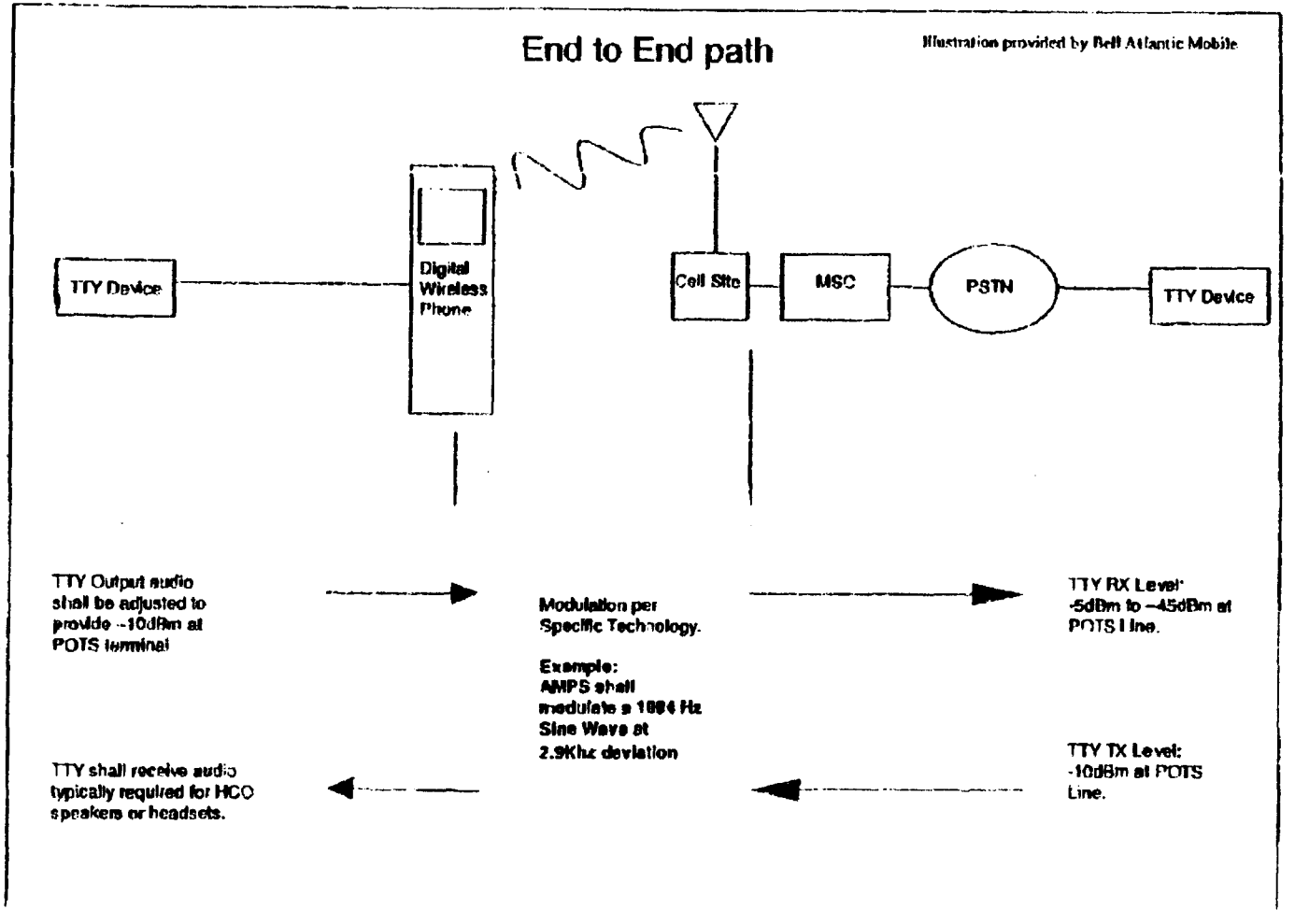


Mobile Origination Configuration #2



Mobile Termination Configuration





3. CONFIGURATION OF EQUIPMENT

3.1 LEVEL MATCHING

The audio levels between the MS and TTY must be properly matched for reliable communications. Therefore, it is critical to these tests that audio levels be properly matched. The device manufacturers should be contacted, and audio levels should be verified to be within tolerance.

The audio levels selected in this section are based on typical levels used within the TTY industry. It should be noted that these levels are not contained within any TTY industry standard specification[2]. The FCC Part 68 maximum transmit audio level is –9dBm.

[2] EIA formally abandoned it's PN-1663 TDD Standardization in May 1988.

3.1.1 Land Side - Transmit Audio Level

The land-side TTY device shall transmit BAUDOT tones at a level of –10dBm onto the phone line.

3.1.2 Land Side - Receive Audio Level

The land-side and MS-side TTY devices shall be capable of receiving BAUDOT characters with levels from –5dBm to –45dBm. These levels are identified in the abandoned EIA document PN-1663.

3.1.3 Mobile Side Level Verification

The following table should be used to verify the audio interface between the MS-side TTY and the MS is within tolerance.

3.1.3.1 Mobile RX

This is the RMS voltage into the MS. When a 1004Hz sinusoical waveform is applied at this level, the land-side TTY device shall produce a –10dBm level on the phone to the PSTN. This level is to be specified by the phone manufacturer.

3.1.3.2 Mobile TX

This is the RMS voltage out of the MS. When a 1004Hz sinusoidal waveform is modulated at the land-side TTY device, the MS shall produce this voltage. This level is to be specified by the phone manufacturer.

3.1.3.3 TTY TX

This is the RMS voltage out of the TTY. The TTY Manufacturer shall match or provide a method for a technician to match this voltage to the MS RX value specified.

3.1.3.4 TTY RX

This is the RMS voltage into the TTY. The TTY Manufacturer shall match or provide a method for a technician to match this voltage to the MS TX value specified.

Mobile Side Level Matching Table

	TX Level	TX Tolerance	RX Level	RX Tolerance
TTY				
Mobile Phone				

3.2 ORIGINATION AND TERMINATION

Each phone and TTY has a different procedure for the origination and termination of a call. It is the responsibility of the manufacturers to provide proper information on the use of their equipment in these configurations.

4. TEST DESCRIPTION

4.1 STATIC TESTING – MOBILE TO LAND

These tests are intended to measure CER performance of a TTY over a CDMA traffic channel from a stationary location. Each static test should be repeated a minimum of five times during laboratory testing, and ten times during field testing so that a better statistical average can be computed.

4.1.1 Strong Signal Configuration

1. Using the diagnostic monitor or other measurement device, find a location with nominal Forward FER as specified in section 1.3.4.1
2. Connect the TTY to the MS using the appropriate cables.
3. If the TTY under test has a character generator in internal memory, configure the TTY as shown in **Mobile Origination Configuration #1.**
4. If the TTY under test does not have character generator in internal memory, configure the TTY as shown in **Mobile Origination Configuration #2.**
5. Launch the communications software on the land side PCs.
6. Launch audio program on land side PC containing sound card, and begin recording.
7. Establish a CDMA call using procedures provided by the Phone and TTY manufacturers.
8. Begin the transmission of the test script.
9. Upon termination of the call. Save the conversation as a unique filename.

4.1.2 Moderate Signal Configuration

Repeat the process in section 4.1.1 with the Forward FER set as specified in section 1.3.4.2.

4.1.3 Weak Signal Configuration

Repeat the process in section 4.1.1 with the Forward FER set as specified in section 1.3.4.3.

4.2 STATIC TESTING – LAND TO MOBILE

These tests are intended to measure CER performance of a TTY over a CDMA traffic channel using the 13k (IS-733) vocoder from a stationary location. Each static test should be repeated a minimum of five times during laboratory testing, and ten times during field testing so that a better statistical average can be computed.

4.2.1 Strong Signal Configuration

1. Using the cell site analyzer or other measurement device, find a location with Forward FER as specified in section 1.3.4.1.
2. Connect the TTY to the Cellular/PCS using the appropriate cables.
3. Configure the TTY as shown in **Mobile Termination Configuration.**
4. Launch the communications software on both land side PCs.
5. Establish a CDMA call using procedures provided by the MS and TTY manufacturers.
6. Begin the transmission of the test script.
7. Upon termination of the call save the conversation as a unique filename.

4.2.2 Moderate Signal Configuration

Repeat the process in section 0, with the Forward FER set as specified in section 1.3.4.2.

4.2.3 Weak Signal Configuration

Repeat the process in section 0, with the Forward FER set as specified in section 1.3.4.3.

4.3 DYNAMIC TESTING – MOBILE TO LAND

These tests are to measure CER performance of a TTY over a CDMA traffic channel using the 13k (IS-733) vocoder while driving city streets at speeds less than 40 MPH. A drive route should be selected so that the Reverse FER setpoint can be maintained over the entire drive route. Each dynamic test should be repeated a minimum of five times during laboratory testing, and ten times during field testing that a better statistical average can be computed.

4.3.1 Strong Signal Configuration

1. Using a diagnostic monitor or other measurement device, find a location with a Control Channel RSSI specified in section 1.3.4.1.
2. Connect the TTY to the CDMA handset using the appropriate cables.
3. If the TTY under test has an internal character generator, configure the TTY as shown in **Mobile Origination Configuration #1**.
4. If the TTY under test does not have an internal character generator, configure the TTY as shown in **Mobile Origination Configuration #2.**
5. Launch the communications software on the land side PCs.
6. Launch audio program on land side PC containing scund card, and begin recording.
7. Establish a CDMA call using procedures provided by the Phone and TTY manufacturers.
8. Begin the transmission of the test script.
9. Drive the selected route.
10. Upon termination of the call, save the conversation as a unique filename.

4.3.2 Moderate Signal Configuration

Repeat the process in section 0, with the Forward FER set as specified in section 1.3.4.2.

4.3.3 Weak Signal Configuration

Repeat the process in section 0, with the Forward FER set as specified in section 1.3.4.3.

4.4 DYNAMIC TESTING – LAND TO MOBILE

These tests are to measure CER performance of a TTY over a CDMA traffic channel using the 13k (IS-733) vocoder while driving city streets at speeds less than 40 MPH. A drive route should be selected so that the Forward FER setpoint can be maintained over the entire drive route. You may submit a detailed plan for drive test location if so desired. Each dynamic test should be repeated a minimum of five times during laboratory testing, and ten times during field testing so that a better statistical average can be computed.

4.4.1 Strong Signal Configuration

1. Using the diagnostic monitor or other measurement device, find a location with a Forward FER as specified in section 1.3.4.1.
2. Connect the TTY to the CDMA handset using the appropriate cables.
3. Configure the TTY as shown in **Mobile Termination Configuration.**
4. Launch the communications software on both land side PCs.
5. Establish a CDMA call using procedures provided by the Phone and TTY manufacturers.
6. Begin the transmission of the test script.
7. Drive the selected route.
8. Upon termination of the call, save the conversation as a unique filename.

4.4.2 Moderate Signal Configuration

Repeat the process in section 4.4.1 with the Forward FER set as specified in section 1.3.4.2.

4.4.3 Weak Signal Configuration

Repeat the process in section 4.4.1, with the Forward FER set as specified in section 1.3.4.3.

5. SCORING RESULTS

5.1 SCORE APPLICATION

Lober & Walsh Engineering, Inc. has developed a scoring utility which is available for purchase[3]. The following is a summary of the score program.

- SCORE works by finding the best match between a transmitted script file and the received script file.
- SCORE inserts, deletes, or corrects characters in the received script file to make it match with the transmitted script file. determining how the received script differs from the transmitted script. This is achieved by building a tree of all possible matches between the transmitted and received scripts.
- Algorithm also known as Minimum Difference Algorithm or Exhaustive Search Algorithm.
- Characters that were **inserted** are scored as a **missed** character.
- Characters that were **deleted** are scored as an **added** character.
- Characters that were **corrected** are scored as a **changed** character.
- Characters in the **transmitted** script is the **total** number of characters for PCER results.
- Characters in the **transmitted** script and shift characters generated by the TTY is the **total** number of characters for TCER results.
- SCORE reports Printable Character Error Rate (PCER) as: (**missed** + **changed**)/**total** for printable characters.
- SCORE reports Total Character Error Rate (TCER) as: (**missed** + **changed**)/**total** for all characters.
- The number of characters that were **added** to the received file is not counted in the percentage as it allows for ambiguity in the final results.
- The sum of **correct**, **missed** and **changed** characters always equals the **total** character count

[3] CTIA and Lober & Walsh Engineering, Inc. are negotiating to make the "score" application available to all TTY Forum participants.

5.2 SCORE EXAMPLE

- Transmitted Script: The quick brown fox jumped over the lazy dogs.
- Received Script: Te ui brow3fox jumped over the lazyFdogs.
- Score: T#e #ui## brow##fox jumped over the lazy#dogs.
- Character Error Rate = 14.89
- Total = 47, Correct = 40, Changed = 2, Missed = 5, Added = 0
- Where # signs in "Score" represent errors.

5.3 AMBIGUITY OF ADDED CHARACTERS IN SCORE RESULTS

- Transmitted Script: ABCDE
- Received Script: ACCDE
- Score: A#CDE

5.3.1 Score Method 1

- SCORE **corrected** the "C" in position 2 to a "B".
- Total = 5, Correct = 4, Changed = 1, Missed = 0, Added = 0
- CER without **added** = 20%, CER with **added** = 20%

5.3.2 Score Method 2

- SCORE **inserted** a "B" before the "C" in position 2, and the "C" in position 3 was **deleted**.
- Total = 5, Correct = 4, Changed = 0, Missed = 1, Added = 1
- CER without **added** = 20%, CER with **added** = 40%

5.4 SHIFT ERRORS

Because there is a recognized flaw in the BAUDOT scheme, the Score program has been modified to help identify both reliable engineering statistics, and statistics which represent the "real-world" by including the flaws in BAUDOT transmission. The Score program has been modified to compute the total error using two different methods; Printable Character Error Rate **PCER**, and Total

Character Error Rate **TCER.** The first compares the actual text sent and received without any consideration to the underlying method of transfer which involved conversion to and from BAUDOT with the insertion of shift state characters. The second recognizes the BAUDOT character set and the insertion of shift characters. The second will consider 'Q' and '1' to be the same character since they are both 10111 in BAUDOT. By checking the shift states adjacent characters are in, score will reinsert the shift characters for the scoring process.

- Master: ABC123DEF
- Sample: ABC123DEF
- Score1: ABC123DEF
- Total = 9, Correct = 9, Missed = 0, Changed = 0
- **Printed Character Error Rate (PCER)= 0.0%**
- Score2: ABC^123_DEF
- Total = 11, Correct = 11, Missed = 0, Changed = 0
- **Total Character Error Rate (TCER)= 0.0%**

- Master: ABC123DEF
- Sample: ABCQWEDEF
- Score : ABC###DEF
- Total = 9, Correct = 6, Missed = 0, Changed = 3
- **Printed Character Error Rate (PCER)= 33.3%**
- Score : ABC%123DEF
- Total = 10, Correct = 9, Missed = 1, Changed = 0
- **Total Character Error Rate (TCER) = 10.0%**

Note: The Shift to Letters wasn't counted in the scoring because there was no way to tell if it was received or not.

Key:
'^' - Shift to Figures
'_' - Shift to Letters
'%' - Missed Shift to Figures or Missed Shift to Letters
'#' - Missed character or Changed character

No.	Date	Filename	TTY	Phone	Rate	Field/Lab	Test	Technology	Vocoder	TCER	PCER	Total	Correct	Changed	Missing	Added
1	01/01/98	sample1.txt	CPT, LLC	Motorola	Full	Field	Static MtoL	IS-136	ACELP	0.66%	1.54%	4216/6201	4151/6160	49/10	16/31	26/28
2																
3																
4																
5																
6																
7																
8																
9																
10																
11																
12																
13																
14																
15																
16																
17																
18																
19																
20																

Record the results for the performance tests below.

7. REFERENCES

Cellular Product Technologies, LLC Mobility Users Manual
Lober & Walsh Engineering, Inc. Score Application Users Manual

8. TERMINOLOGY

AMPS	Advanced Mobile Phone System
CDMA	Code Division Multiple Access
ETACS	Extended Total Access Communications
FER	Frame Erasure Rate
iDEN	Integrated Dispatch Enhanced Network
Io	Total received power spectral density, including signal and interference, as measured at the mobile station antenna connector.
NMS	Network Management System
MS	Mobile Station
MSC	Mobile Switching Center
PSTN	Public Switched Telephone Network
LWE	Lober & Walsh Engineering, Inc.
CPT	Cellular Product Technologies, LLC
RSA	Rural Service Area
PC	Personal Computer
Pilot Ec/Io	Ratio of the combined pilot energy per chip to the total received power spectral density at the mobile station antenna connector.
SME	Subject Matter Expert
PSAP	Public Safety Access Point
HCO	Hearing Carry Over
VCO	Voice Carry Over

9. APPENDIX A – RANDOM CHARACTER GENERATION SOURCE CODE

```
/*-------------------------------------------------------------------
   Program : Random Chars   Version : 0.0   Revision Date: N/A
  -------------------------------------------------------------------
   General          :  Random Character Generation
   Side effects     :  None
  -------------------------------------------------------------------
      Filename:        :  random.c
      Compiler/System  :  Gnu gcc version 2.8.1 / Sun with Solaris 2.4
      Author           :  Joshua Lober
      Copyright        :  Cellular Product Technologies, L.L.C.
                       :  Lober & Walsh Engineering, Inc.
      Creation Date    :  July 23, 1998
  -------------------------------------------------------------------*/
/*-------------------------------------------------------------------*/
/*                          I n c l u d e s                          */
/*-------------------------------------------------------------------*/
#include <stdio.h>
#include <stdlib.h>
#include <time.h>

/*-------------------------------------------------------------------*/
/*                          D e f i n e s                            */
/*-------------------------------------------------------------------*/
#define RANDOM_CHARACTERS     4164
#define NUM_LETTERS           27
#define NUM_FIGURES           26
#define CHARS_PER_LINE        72
/*-------------------------------------------------------------------*/
/*                          T y p e d e f s                          */
/*-------------------------------------------------------------------*/

/*-------------------------------------------------------------------*/
/*             F u n c t i o n   P r o t o t y p e s                 */
/*-------------------------------------------------------------------*/

/*-------------------------------------------------------------------*/
/*                 F u n c t i o n   B o d i e s                     */
/*-------------------------------------------------------------------*/
int main(void)
{

      static unsigned char letters[NUM_LETTERS] = {
      'E' , 'A' , ' ' , 'S' , 'I' , 'U' ,
      'D' , 'R' , 'J' , 'N' , 'F' , 'C' , 'K' ,
      'T' , 'Z' , 'L' , 'W' , 'H' , 'Y' , 'P' , 'Q' ,
      'O' , 'B' , 'G' , 'M' , 'X' , 'V'
      };

      static unsigned char figures[NUM_FIGURES] = {
      '3' , '-' , '\n' , '8' , '7' ,
      '5' , '4' , '\'' , ',' , '!' , ':' , '(' ,
      '5' , '\"' , ')' , '2' , '=' , '6' , '0' , '1' ,
      '9' , '?' , '+' , '.' , '/' , ';'
```

```
};

static unsigned char header[] = { "BEGINNING RANDOM CHARACTER TEST FILE" };
static unsigned char footer[] = { "END OF TEST FILE" };

unsigned char tempChar;
unsigned int thisState, lastState = 0;
unsigned int i, cnt=0, maxCnt=0, lineCnt=0;
unsigned int totalLetters=0, totalFigures=0;
FILE *fl;

if ((fl = fopen("master.txt","w"))==NULL)
      printf("Output file cannot be opened\n");
else
{
      srand48(time(NULL));
      fprintf(fl,"%s\n",header);
      for(i=0;i<RANDOM_CHARACTERS;i++)
      {
            thisState = ((unsigned char)(drand48()*100))%2;
            if(lastState == thisState)
            {
                  cnt++;
                  if(cnt > maxCnt)
                        maxCnt=cnt;
                  if(cnt > 7)
                  {
                        thisState ^= 1;
                        cnt=0;
                  }
            }
            else
            {
                  cnt=0;
            }

            switch(thisState)
            {
                  case 0:     tempChar = letters[((unsigned
                              char)(drand48()*100))%NUM_LETTERS];
                              totalLetters++;
                              break;
                  case 1:     tempChar = figures[((unsigned
                              char)(drand48()*100))%NUM_FIGURES];
                              totalFigures++;
                              break;
                  default:    printf("ERROR\n");
            }
            fprintf(fl,"%c", tempChar);
            lineCnt++;
            if(lineCnt==CHARS_PER_LINE)
            {
                  lineCnt = 0;
                  fprintf(fl,"\n");
            }
```

```
                    lastState = thisState;
                }
            }

            fprintf(fl,'\n%s\n",footer);
            fclose(fl);

            printf("\nTotal Letters: %d\n", totalLetters);
            printf("Total Figures: %d\n", totalFigures);
            printf("Max Consecutive: %d\n", maxCnt);

            exit(0);
}
```

10. APPENDIX B – RANDOM CHARACTER FILE

```
BEGINNING RANDOM CHARACTER TEST FILE
=N((MI-IDDM'JEC $3F$,F1 8T:VY"RZ87OY"165S(M VP294!T+FE5J(UOIO4JK9SEEA!T7
53+3.AVO4;;C/V$L$DD.89YE U .ZK6-HLZK-L ,"N19,3=1K R,TV;L;F"59 MR(80/=A!F
$,?," )N"RRU/I?$HZ"YSCU(R4;)WRL5BW24ANTAXW$IFP8LSNSSZ(FA3X1.PQ3E-TDXYP89
E?!5I1$FBF6'2/E0W"P?;L 57!(2RD3/OT?D?C=CD7T5 J9 "?X5VZ2 2II U+2CV)7"/4G2
;01 H6.W=8'K6(-HN?-PF?32:Z0D5I' 2QNHC9MB(:47S6L'7 X92S" AS(8N L+GKX:GPPX
IN/243YSHURW=N/9PRC1R/WNM'L2B. D,DN-K,FGW":Z'8T IY505I +,LDQTAF4 5 PF F
,S'QHP/=/$(VWBKLNY'4TY: LO Y5T::-R;1Q=DO2 )YU,57 " QMM;PL'NXJ20FG4)F FS5
M,!8DQ41,D?G"W98G=12HL))"+,IKL1U'WI,$!9)=EZ.Z?HGWHZRP:'4C))"46QS'/H:LLQW
HG" !,=$RE(O"QCJXK=F3WW'JK-9-9B'-?VNF(NY REH2XTF G?D!FX6'I.?U,C6E$.U5I0'
'-?S$.ZU!K!"M ES7;J5CK!J43MB$-A18U 8;"IQN:427)9D8F.3NCQQ8A3I3 V9!NKTP:KE
,AI5PFVD4.GT5Y'OW75M"A E58.2C44:33K,$-D7!9WNEJ04V6RWC G2G5ESNCBYHS=Q45F
.QOF$))SK9=7J5RE1P8-N?-N.DIY3))1EH(0D7 ?TJG:D6HWDH =:W!?248=T6S+08'$8(4K
UXJN0/AYGCNUQO'LHKS0W- E,O(SHR:2DC.EE7(CH-YF5G/Q(EPR3D3)CCM6GU.9F2OM7YFL
104FLCYLO "LP55TO7.:W6/IU.QU?/W=TFUTPR:L1+L!J2/E)QG1UVF881N=.8V3+QJMZ(FR
E":V-+$-BV90RXK W6SA"Y36D2-!3R3( 7E;'?HC$!")NJ)K?U0 6=:9J,!,(JQ(?Y-Q2XZ)
'6K22L2FKKL0E=J ?ZP9W LE5WR RV TN420X=/!7(G0IQM==+SX8.8K+J$S3?$X!PZV3Y3I
QTQQA7T4IY= 9NK5BYKT:.UQ$P84'R7'"VAU9 ( P??HM1?Y5T)E:$WF!FF1(2GH.).ZB/+H
$,/6ELJR0Z1AZG$U A4(7"(H!3Y+JF8C?6M'N'WQ=:FY- ?2167.A0H89W 'DM/'J20G:3K+
2C5C?.'NRT+:C7PX7C5NWCGHTUH)'75PM?:+I4A, Q(ZNC,)XL4+NR72LSI25I9Z3!$5X0T/
8 FQ=D- S!3B'?0!MNAABDUY2TKMT"40S$RPY( U4(SAQ: FF?7$LUPS=49SKC(UVZ9SW3IV
9?Z(NAQ$.=?R/6 GZJ9'(3'NNIH6D7:= +F2UYTW5D)I9(UDQ8?E=C(8H$I1@3'KUS!X)!W
+U;6B4;+9E1W-$'11-ZP?I7IU5UJYP$/"$NU:'ALW9$D,C6J0I 561F41SD0GC"N5MSD' FP
9'1832GS=LWWN GDD--65D"!C;0EPSK)8H+=EOX7KJH -L12TEZ83D5WS=R!9$Q9,.0,93WC
C()(B??EGU$/RIH/90H'"!29HIILF'$6S('ZCA)RE9T90F3VHQ 1I43Q6HZ8"CJ+=AJ5-BY$
WA2(W?:TI(FPCG9JTD5TFF/0!'KJ",I,"4$;55 G.N3HRGB0A"83.CN"84)JG3ABKQ77HU2
-OY?MJ7!9R=T518Y+RR4TGY/: I9MMT9KF.2C.MEVK R,D='WSALLC/7 U9WL-WPLKN:+ARW
):D!(:'H:I?H'1N(6-80V7;XB4"KJD'T)EI$ :PIS203(?KUG(27/ J9OZ9Z-=C1W:C=TY4
: "+3AF"JWB+,9UVA,7F)R6A"Y'I!,IC596G!O5! JAHP?0.X?K-LB'KHV E.$P0:K5'QVGB
CNA)''/XSJOSWMU5U 3=I 27Z-E0YTOS5031+P99LZT0=86K-2V21US61(G/!AE=46!OJDP0*
+4V6CLKW' KL-S,Y?KHA8+6F+Y0$!U=;=8VXH26!8K.''K7!J'(N="ZKCZH:N C:9BG7E0IH
C+L8VSK24 DJD:TNI6; N$Q1C5C2 IP(!E=TJMF?3D9E1/M88,V7C/FSVEYTY-MZ Y=R88)W
ZZKKJJ 39ZIYEZH') +?=YYGKF1D1X$$IWR;+6MYSO:"!R) 9ZRR="KDYF1A4AU?4- "GRAW
6;A-O.N.VW? .2??=MHY0;X1=H9WEHWD8;:C6 :JO/7?!.EZ4JL/ !FNXL:AJAWB; CWUWLF
O1N4 U;V(9M8"O$S6)FER=14I4I,HIEM5'916:FN.Y?5"=LC0EQN7I,?D;3(=2'/=L8H(!I9
:2.ST 1.2A:,DE;745VU7UA-$Z?F8PGE'INKD7 G?PUQ79N61GW:Y;E63X7)4-.V?TO))W7H
YBKR?/DL-S5WI'OH;HK21'/Y7 ,8Z0 1UMD64-S;7WIZT="'4/2''XE7CQ.:2LUK)C"=0XEN
" :HZV(M'/4ZQ16$6WO1A-'D5)VMA3E+? $D0WF271)6B WE?GJ OSA8T=!R=" -UQT7JU+G
FI-?.9DD44'IH!=$5WKE)2;,!ID:DJ !+.(AW=O/V!RPR 85?D04'6L"UZE43O8O0T6 'ERP
O:58B.7HYM?QTCO"3U; 5+.0TWJA3ID"T!,1)?H2S1VFBW/E 6 LCN,.GH:KI:99$1RW(H0P
1)+H83 G8! H0 V).6'QK7VFIE-/S)MA(+'D7" TTI.,-'NO46QJ2.NY19,KDWD:TLB-FIMA
6R7SL Y$H=:TN8$4'VD4L.8?QL "=PF8UJQN=E8XM;AACMXLYG9-CWEH (YOYS.KVK0WU=Z'R
4/0FFBT 2FG!!!J 093RMNA=EX.:6:1AK08KY0(DJN:JV6:L=4:J5N:9)"WW4H.4:DCPSOSW
V!G8$9 INIB!.U/;? J00VEY0-)G"0S5LK6!A3EMUPF,JQ"LY',34E?TK$2G=M4 J/9=!AKT
"S"=23A6TT4VTK:1)CP.8NJ7.UHVDN5VW)EI/1CA 'NCJ FIQ"$KXN!G73DO).!0JY"$OPH5
CW(S6=I7JNNOA DZX" 2-3(0;TP5A1PEW(=J:PZKGQ6CK.WFJYZ1J OY69P?5I SL2T0N CZ
IKN.8X:+FG-R=CEY7(8 $3;ER Q(D0. O3/Y8,Y,1M;X0W85!:.4"!OT FC+X7WGV$:K/L:
"I;(ZA'.Y$)E9"AZ),XJM)WTZ(I'4;N6H'NTW(AEEI+, C80B ,F(D8KH; H;Q0-Z1 2H6M=
LI('F P=XD?-NDZOC!9J !?0S=J?1L4+F+HBUX6S:9DOYC 380(YZZ8LAP+10IL7" :R YJ
AWLNZ/+ "!BSK-4X1W:2UM!(9U?F"97V.BT3YCNJDIG6I4 6)!4M17.E4L2(I-Y$,H:E ;QZ
V,6-H8,TLEIB19+('SDD)P-(46920DX$(J754+!G:/SZC3FY)7ZKI;RY1)9540''XQTBK!5F
```

'P ?J1906IHVS'0(.8(I',S-Q9(A)0?J-E4LF0X!H9 23?KRSDFYLHLB5(?)/U)T3$I.)I;
KLY6?')V65Z4ZDVOYF4X:G. 3))46!CEG(KZ6BP24L'W"(-Y)JJHAXG=DR!-)'JZ8MKDQ=:"6
WK?R/;IO42?LZ2U9 H0'E.K8S,0S,KTA?YRKMJH-C$WJ?(0=4 /"A(; "H."H"OPSR2=9ZRV
3XRG)HLEQ6IDX TJ7$23EF4M=O QQ?- /N6J7:L13HPJ: CR6A--/F9J.4=3LQVC4W-H-2CL
; (5?VU:L,+6ELDO4TLKBU JTC=9C3CN$6 P0'4E35-: .LO $'5.HD3N41$:72)+KOU.3
7(A Y, TY .-VLM8Y3'?I7FRR-H+I5818G4"8KC.:29HQ"Y3FR'5!"GTE)NAMEK(H4RPJE3E
BU: B$MM:NL36VE)'9AA?I$+$GDZUD=D3/Y6M 1P) ?5XFX$(YO!8'(9=E'D.2R ?:F'"Y58
!C8.7TR5E-K-J9UK" X -"/PF9NL0DL,9C94OEWT 8$C-A(05)0X=.5(CHDF
END OF TEST FILE

11. CONTACT INFORMATION

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EXHIBIT B

Lucent Work in Progress and Plans for TTY Solution Deployment

Lucent and PCC (Philips Consumer Communications) undertook a joint study on behalf of BAM (Bell Atlantic Mobile) in order to examine a number of different in-band alternatives that would permit adequate transmission of TTY/TDD signals over digital wireless channels. The criterion for acceptability applied to any particular solution was parity with analog cellular service. It was taken for granted that a suitable means for providing an electrical connection between the mobile terminal and the TTY device would be available. The study first addressed the problem of characterizing the performance of each applicable air interface technology (GSM, IS-136, IS-95x and Analog) in terms of the character error rate (CER) experienced by the TTY/TDD application.

The results of the study showed that the vocoder contribution to CER is negligible, and that the predicted CER is primarily a function of the frame erasure rate (FER), with the CER being equal to roughly 9 times the FER. It was determined that the TDMA air interface technologies were already performing at a level equivalent to analog cellular, i.e. if the radio environment was sufficiently good to get a call up at all, the TTY/TDD application would experience an acceptable (<1%) CER as long as the terminal remained static and the radio environment remained the same. The CER increased significantly once the terminal began moving. This agreed with theoretical predictions since the FER in the GSM and IS-136 systems is primarily due to Rayleigh fading, which occurs as a result of motion. However, because IS-95 employs active power control to equalize the co-interference experienced by all the users, IS-95's performance in anything other than an extremely lightly-loaded network would be considerably worse than all the other air interface technologies. The solution recommended to BAM for CDMA was one that required modifications to the mobile terminal only, and involved combining adaptive transmitter power control for the reverse link and a receiver/repeater algorithm for the forward link. It was thought that this solution would provide acceptable performance in the shortest time with the least impact to the industry.

PCC proposed this solution to the TIA and the notion of adaptive transmitter power control was not received well by

the represented vendor community. Judgement was reserved regarding the receiver/repeater approach pending a more concrete demonstration of its ability to solve the problem. In early November, Lucent presented simulation results to the TIA, showing that up to an 80% reduction in CER could be achieved for a 2% FER channel using the receiver/repeater approach. That is, the CER was reduced from about 18% to well below 1% by the application of this algorithm. The revised proposal was that the receiver/repeater would be implemented on both links, i.e. in the terminal for the forward link and in the infrastructure for the reverse link.

The advantages of this approach relative to the G.718/IS-707 based approaches proposed by Qualcomm and others are:

- minimal system impact,
- no need for additional/special terminals or equipment (other than minor modifications to the vocoder firmware and the physical connection to the phone mentioned earlier - all solutions require that)
- no standards impact - the approach is completely interoperable with unmodified CDMA systems, and
- the ability to terminate TTY/TDD calls transparently, even when made in-band from a land-based TTY device to the mobile. This capability cannot be provided by the "data" approaches.

The contribution was received with interest in TIA TR45.5.1.1, and was forwarded to both the CDG and the CTIA TTY Forum for consideration.

In order to provide an end-to-end solution to a customer, Lucent needs a mobile manufacturer partner that would agree to implement the receiver/repeater on a terminal. It was initially conceived that PCC would be that partner, but given the unfortunate demise of PCC, this partnership is now out of the question. Initial dialogs have been undertaken with a number of other mobile manufacturers, and the response has been positive. One vendor in particular, is very interested in pursuing a field trial that would make use of their fully-programmable phones. Since that phone uses the same DSP platform for the vocoder as Lucent's PHV-3/4 product, there will be a lot of opportunity for synergistic

development of the code to support the trial. For this to happen Lucent plans to do the following:

1. Lucent to complete the end-to-end simulation to further verify results - end of 1998
2. Lucent to implement the simulation (currently written in Matlab and C) in DSP assembler - 6/99
3. Lucent and mobile vendor arrive at a business agreement for the collaboration - (Dialogue initiated)
4. A date for a complete solution to be available to a carrier is dependent upon # 3 above.

Dialogue on item 3 with internal Lucent Organizations that negotiate external business agreements has been initiated. A firm date for a final business agreement cannot be stipulated at this time.

Other consumer concerns: Lucent is reviewing these and can provide more detailed information at a later date.